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Integumentary System Module 1: Introduction to the Integumentary System class="introduction"

Your skin is a vital part of your life and appearance (a–d). Some people choose to embellish it with tattoos (a), makeup (b), and even piercings (c). (credit a: Steve Teo; credit b: “spaceodyssey”/flickr; credit c: Mark/flickr; credit d: Lisa Schaffer)



(a)



(b)



(c)



(d)

Note:

Chapter Objectives

After studying the chapter, you will be able to:

- Describe the integumentary system and the role it plays in homeostasis
- Describe the layers of the skin and the functions of each layer
- Describe the accessory structures of the skin and the functions of each
- Describe the changes that occur in the integumentary system during the aging process
- Discuss several common diseases, disorders, and injuries that affect the integumentary system

- Explain treatments for some common diseases, disorders, and injuries of the integumentary system

What do you think when you look at your skin in the mirror? Do you think about covering it with makeup, adding a tattoo, or maybe a body piercing? Or do you think about the fact that the skin belongs to one of the body's most essential and dynamic systems: the integumentary system? The integumentary system refers to the skin and its accessory structures, and it is responsible for much more than simply lending to your outward appearance. In the adult human body, the skin makes up about 16 percent of body weight and covers an area of 1.5 to 2 m². In fact, the skin and accessory structures are the largest organ system in the human body. As such, the skin protects your inner organs and it is in need of daily care and protection to maintain its health. This chapter will introduce the structure and functions of the integumentary system, as well as some of the diseases, disorders, and injuries that can affect this system.

Integumentary System Module 2: Layers of the Skin

By the end of this section, you will be able to:

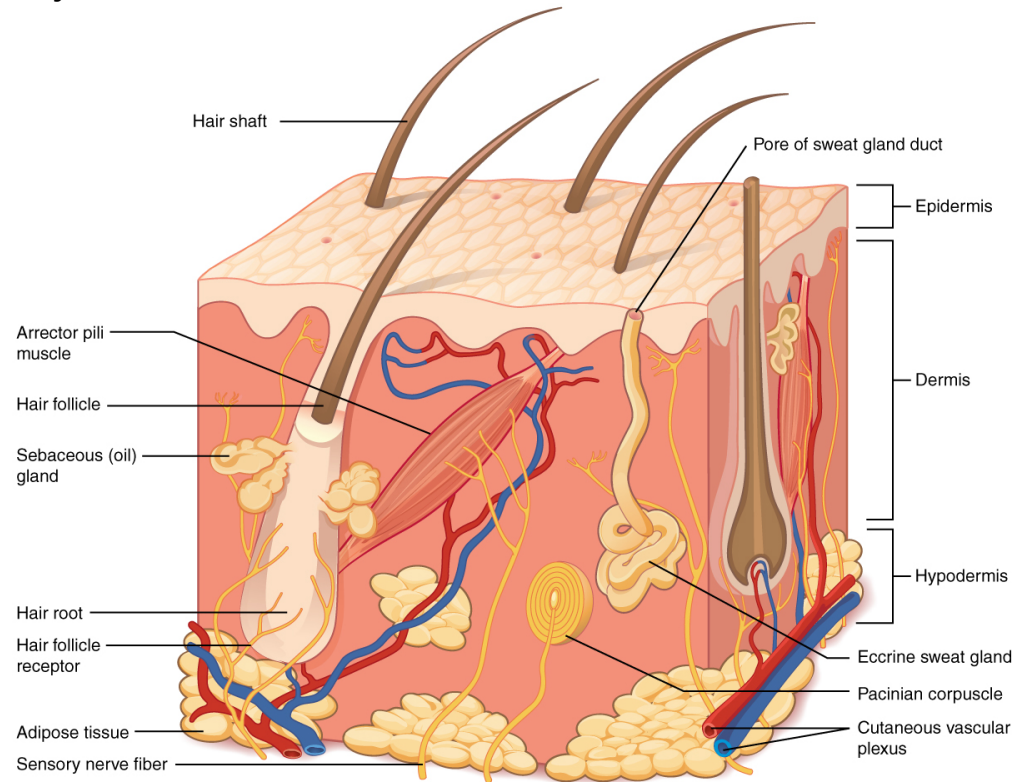
- Identify the components of the integumentary system
- Describe the layers of the skin and the functions of each layer
- Identify and describe the hypodermis and deep fascia
- Describe the role of keratinocytes and their life cycle
- Describe the role of melanocytes in skin pigmentation

NOTE: Chapter Objectives: After studying the chapter, you will be able to: Describe the integumentary system and the role it plays in homeostasis. Describe the layers of the skin and the functions of each layer. Describe the accessory structures of the skin and the functions of each. Describe the changes that occur in the integumentary system during the aging process. Discuss several common diseases, disorders, and injuries that affect the integumentary system. Explain treatments for some common diseases, disorders, and injuries of the integumentary system.

What do you think when you look at your skin in the mirror? Do you think about covering it with makeup, adding a tattoo, or maybe a body piercing? Or do you think about the fact that the skin belongs to one of the body's most essential and dynamic systems: the integumentary system? The integumentary system refers to the skin and its accessory structures, and it is responsible for much more than simply lending to your outward appearance. In the adult human body, the skin makes up about 16 percent of body weight and covers an area of 1.5 to 2 m². In fact, the skin and accessory structures are the largest organ system in the human body. As such, the skin protects your inner organs and it is in need of daily care and protection to maintain its health. This chapter will introduce the structure and functions of the integumentary system, as well as some of the diseases, disorders, and injuries that can affect this system. Although you may not typically think of the skin as an organ, it is in fact made of tissues that work together as a single structure to perform unique and critical functions. The skin and its accessory structures make up the **integumentary system**, which provides the body with overall protection. The skin is made of multiple layers of cells and tissues, which are held to underlying structures by connective tissue ([\[link\]](#)). The deeper layer of skin is well vascularized

(has numerous blood vessels). It also has numerous sensory, and autonomic and sympathetic nerve fibers ensuring communication to and from the brain.

Layers of Skin



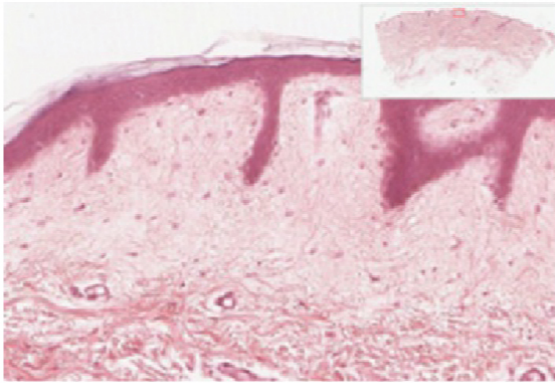
The skin is composed of two main layers: the epidermis, made of closely packed epithelial cells, and the dermis, made of dense, irregular connective tissue that houses blood vessels, hair follicles, sweat glands, and other structures. Beneath the dermis lies the hypodermis, which is composed mainly of loose connective and fatty tissues.

The Epidermis

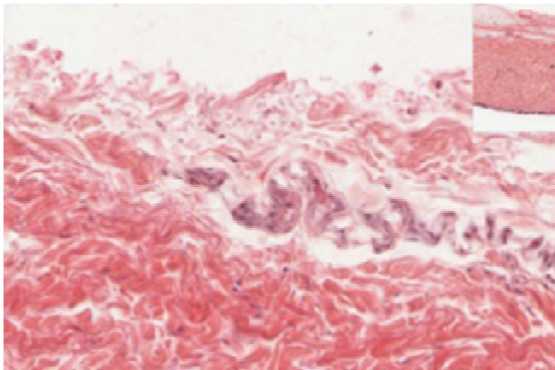
The **epidermis** is composed of keratinized, stratified squamous epithelium. It is made of four or five layers of epithelial cells, depending on its location

in the body. It does not have any blood vessels within it. Tissue without its own blood supply is referred to as **avascular**. Skin that has **four layers** of cells is referred to as **thin skin**. From deep to superficial, these layers are the stratum basale, stratum spinosum, stratum granulosum, and stratum corneum. Most of the skin can be classified as thin skin. **Thick skin** is found only on the palms of the hands and the soles of the feet. It has a 5th layer called the **stratum lucidum**, located between the stratum corneum and the stratum granulosum ([\[link\]](#)).

Thin Skin versus Thick Skin



(a)



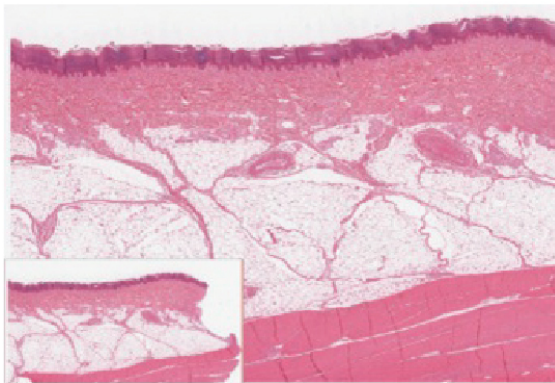
(b)

These slides show cross-sections of the epidermis and dermis of (a) thin and (b) thick skin. Note the significant difference in the thickness of the epithelial layer of the thick skin. From top, LM $\times$ 40, LM $\times$ 40.

(Micrographs provided by the
Regents of University of
Michigan Medical School ©
2012)

The cells in all of the layers except the stratum basale are called keratinocytes. A **keratinocyte** is a cell that manufactures and stores the protein keratin. **Keratin** is an intracellular fibrous protein that gives hair, nails, and skin their hardness and water-resistant properties. The keratinocytes in the stratum corneum are dead and regularly slough away, being replaced by cells from the deeper layers ([link](#)).

Epidermis

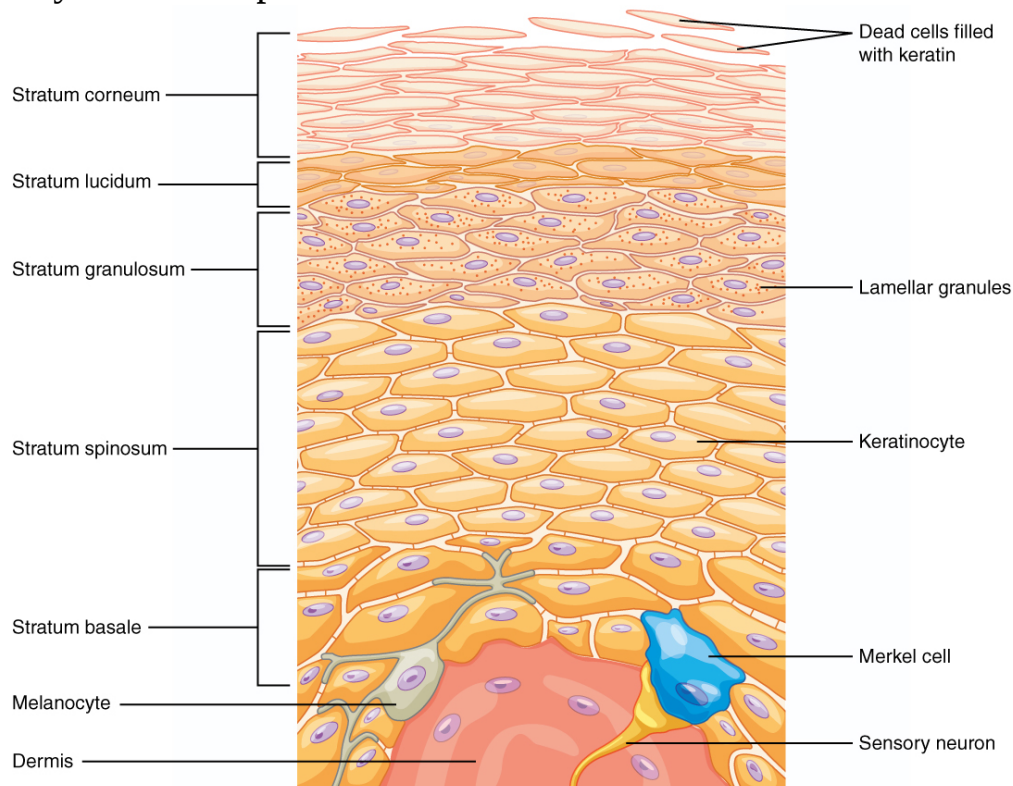


The epidermis is epithelium composed of multiple layers of cells. The basal layer consists of cuboidal cells, whereas the outer layers are squamous, keratinized cells, so the whole epithelium is often described as being keratinized stratified squamous epithelium. LM × 40. (Micrograph provided by the Regents of University of Michigan Medical School © 2012)

Stratum Basale

The **stratum basale** (also called the stratum germinativum) is the deepest epidermal layer and attaches the epidermis to the the connective tissue of the dermis. The cells in the stratum basale bond to the dermis via intertwining collagen fibers, referred to as the basement membrane. A finger-like projection, or fold, known as the **dermal papilla** (plural = dermal papillae) is found in the superficial portion of the dermis. Dermal papillae increase the strength of the connection between the epidermis and dermis; the greater the folding, the stronger the connections made ([\[link\]](#)).

Layers of the Epidermis



The epidermis of thick skin has five layers: stratum basale, stratum spinosum, stratum granulosum, stratum lucidum, and stratum corneum.

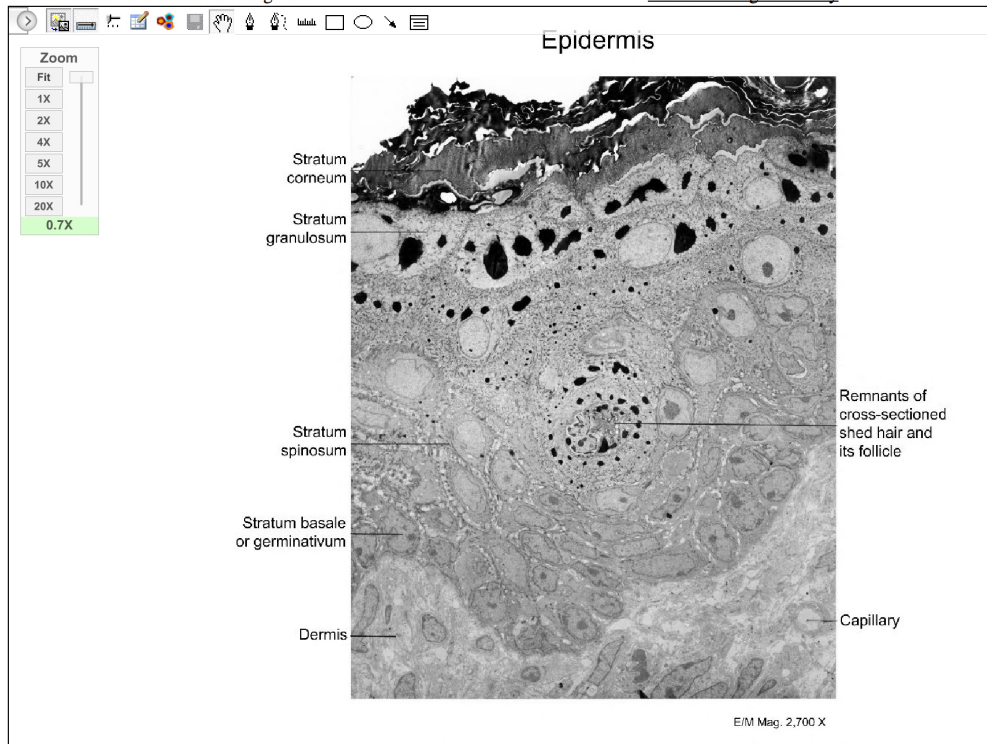
The stratum basale is a single layer of cells primarily made of basal cells. A **basal cell** which forms keratinocytes of the epidermis. All of the keratinocytes are produced from this single layer of cells, which are constantly going through mitosis to produce new cells. As new cells are formed, the existing cells are pushed superficially away from the stratum basale. The second is a **melanocyte**, a cell that produces the pigment melanin. **Melanin** gives hair and skin its color, and also helps protect the living cells of the epidermis from ultraviolet (UV) radiation damage.

In a growing fetus, fingerprints form where the cells of the stratum basale meet the papillae of the underlying dermal layer (papillary layer), resulting in the formation of the ridges on your fingers that you recognize as fingerprints. Fingerprints are unique to each individual and are used for forensic analyses because the patterns do not change with the growth and aging processes.

Stratum Spinosum

As the name suggests, the **stratum spinosum** is spiny in appearance due to the protruding cell processes that join the cells via a structure called a **desmosome**. The desmosomes interlock with each other and strengthen the bond between the cells. The stratum spinosum is composed of eight to 10 layers of keratinocytes, formed as a result of cell division in the stratum basale ([\[link\]](#)).

Cells of the Epidermis



The cells in the different layers of the epidermis originate from basal cells located in the stratum basale, yet the cells of each layer are distinctively different. EM $\times 2700$.

(Micrograph provided by the Regents of University of Michigan Medical School © 2012)

The keratinocytes in the stratum spinosum begin the synthesis of keratin and release a water-repelling substance that helps prevent water loss from the body, making the skin relatively waterproof. As new keratinocytes are produced atop the stratum basale, the keratinocytes of the stratum spinosum are pushed into the stratum granulosum.

Stratum Granulosum

The **stratum granulosum** has a grainy appearance due to further changes to the keratinocytes as they are pushed from the stratum spinosum. The cells (three to five layers deep) become flatter, their cell membranes thicken, and they generate large amounts of the protein keratin, which give the layer its grainy appearance. The nuclei and other cell organelles disintegrate as the cells die, leaving behind the keratin and cell membranes that will form the stratum lucidum, the stratum corneum, and the accessory structures of hair and nails.

Stratum Lucidum

The **stratum lucidum** is a smooth, seemingly translucent layer of the epidermis located just above the stratum granulosum and below the stratum corneum. This thin layer of cells is found only in the thick skin of the palms, soles, and digits. The keratinocytes that compose the stratum lucidum are dead and flattened (see [\[link\]](#)). These cells are densely packed with clear protein rich in lipids, which gives these cells their transparent (i.e., lucid) appearance and provides a barrier to water.

Stratum Corneum

The **stratum corneum** is the most superficial layer of the epidermis and is the layer exposed to the outside environment (see [\[link\]](#)). The increased keratinization (also called cornification) of the cells in this layer gives it its name. There are usually 15 to 30 layers of cells in the stratum corneum. This dry, dead layer helps prevent the penetration of microbes and the dehydration of underlying tissues, and provides a mechanical protection against abrasion for the more delicate, underlying layers. Cells in this layer are shed periodically and are replaced by cells pushed up from the stratum granulosum (or stratum lucidum in the case of the palms and soles of feet). The entire layer is replaced during a period of about 4 weeks. Cosmetic procedures, such as microdermabrasion, help remove some of the dry, upper layer and aim to keep the skin looking “fresh” and healthy.

Dermis

The **dermis** might be considered the “core” of the integumentary system (derma- = “skin”), as distinct from the epidermis (epi- = “upon” or “over”) and hypodermis (hypo- = “below”). It contains blood and lymph vessels, nerves, and other structures, such as hair follicles and sweat glands. The dermis is made of two layers of connective tissue that compose an interconnected mesh of elastin and collagenous fibers, produced by fibroblasts ([\[link\]](#)).

Layers of the Dermis



This stained slide shows the two components of the dermis—the papillary layer and the reticular layer. Both are made of connective tissue with fibers of collagen extending from one to the other, making the border between the two somewhat indistinct. The

dermal papillae extending into the epidermis belong to the papillary layer, whereas the dense collagen fiber bundles below belong to the reticular layer. LM $\times$ 10. (credit: "kilbad"/Wikimedia Commons)

Papillary Layer

The **papillary layer** is made of loose, areolar connective tissue, which means the collagen and elastin fibers of this layer form a loose mesh. This superficial layer of the dermis projects into the stratum basale of the epidermis to form finger-like dermal papillae (see [\[link\]](#)). Within the papillary layer are fibroblasts, a small number of fat cells (adipocytes), and an abundance of small blood vessels. In addition, the papillary layer contains phagocytes, defensive cells that help fight bacteria or other infections that have breached the skin. This layer also contains lymphatic capillaries, nerve fibers, and touch receptors called the Meissner corpuscles.

Reticular Layer

Underlying the papillary layer is the much thicker **reticular layer**, composed of dense, irregular connective tissue. This layer is well vascularized. The reticular layer appears reticulated (net-like) due to a tight meshwork of fibers. **Elastic fibers** provide some elasticity to the skin, enabling movement. Collagen fibers provide structure and strength. In addition, collagen binds water to keep the skin hydrated. Collagen injections and Retin-A creams help restore skin turgor by either introducing collagen externally or stimulating blood flow and repair of the dermis, respectively.

Hypodermis

The **hypodermis** (also called the subcutaneous layer or superficial fascia) is a layer directly below the dermis and serves to connect the skin to the underlying fascia (fibrous tissue) of the bones and muscles. It is not strictly a part of the skin, although the border between the hypodermis and dermis can be difficult to distinguish. The hypodermis consists of well-vascularized, loose, areolar connective tissue and adipose tissue, which functions as a mode of fat storage and provides insulation and cushioning for the integument.

Note:

Everyday Connection

Lipid Storage

The hypodermis is home to most of the fat that concerns people when they are trying to keep their weight under control. It is sometimes not considered to be an official layer of the skin. Adipose tissue present in the hypodermis consists of fat-storing cells called adipocytes. This stored fat can serve as an energy reserve, insulate the body to prevent heat loss, and act as a cushion to protect underlying structures from trauma.

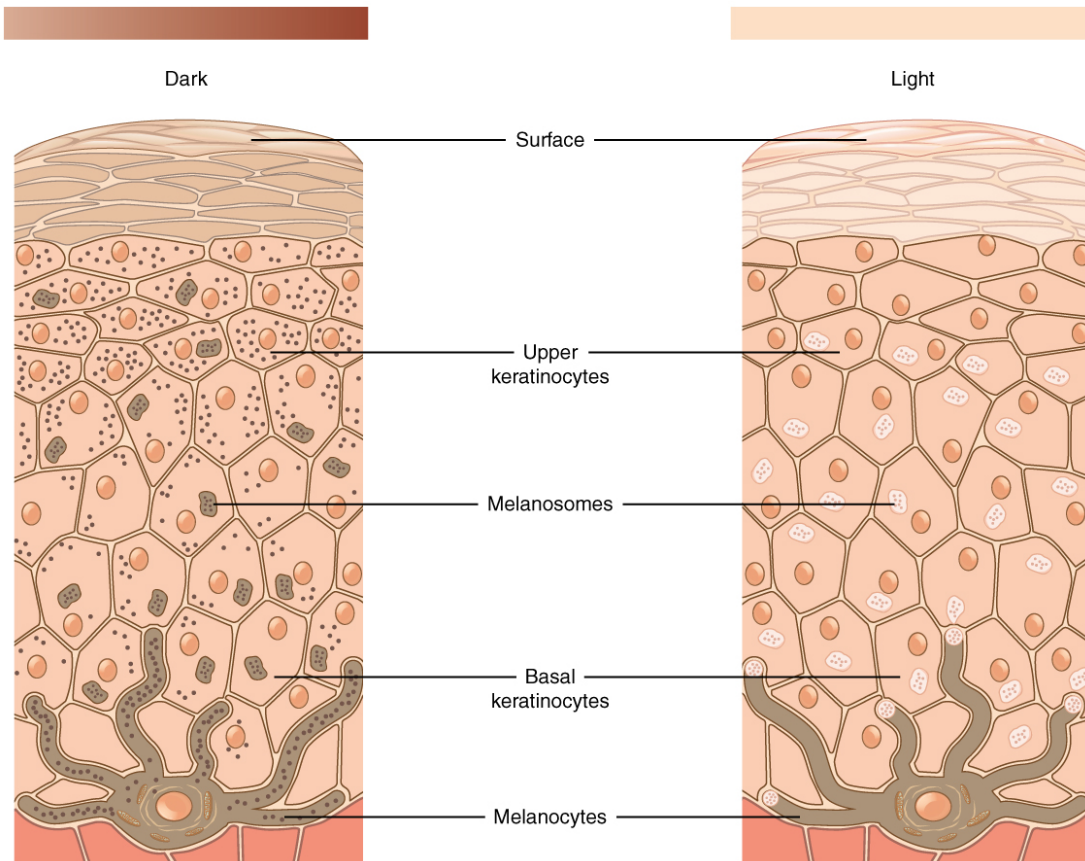
Where the fat is deposited and accumulates within the hypodermis depends on hormones (testosterone, estrogen, insulin, glucagon, leptin, and others), as well as genetic factors. Fat distribution changes as our bodies mature and age. Men tend to accumulate fat in different areas (neck, arms, lower back, and abdomen) than do women (breasts, hips, thighs, and buttocks). The body mass index (BMI) is often used as a measure of fat, although this measure is, in fact, derived from a mathematical formula that compares body weight (mass) to height. Therefore, its accuracy as a health indicator can be called into question in individuals who are extremely physically fit.

Pigmentation

The color of skin is influenced by a number of pigments, including melanin, carotene, and hemoglobin. Recall that melanin is produced by cells called

melanocytes, which are found scattered throughout the stratum basale of the epidermis. The melanin is transferred into the keratinocytes. a id="fig-ch05_01_07" document=""/>).

Skin Pigmentation



The relative coloration of the skin depends of the amount of melanin produced by melanocytes in the stratum basale and taken up by keratinocytes.

Melanin occurs in two primary forms. Eumelanin exists as black and brown, whereas pheomelanin provides a red color. Dark-skinned individuals produce more melanin than those with pale skin. Exposure to the UV rays of the sun or a tanning salon causes melanin to be manufactured and built up in keratinocytes, as sun exposure stimulates keratinocytes to secrete chemicals that stimulate melanocytes. The accumulation of melanin in keratinocytes results in the darkening of the

skin, or a tan. This increased melanin accumulation protects the DNA of epidermal cells from UV ray damage and the breakdown of folic acid, a nutrient necessary for our health and well-being. In contrast, too much melanin can interfere with the production of vitamin D, an important nutrient involved in calcium absorption. Thus, the amount of melanin present in our skin is dependent on a balance between available sunlight and folic acid destruction, and protection from UV radiation and vitamin D production.

It requires about 10 days after initial sun exposure for melanin synthesis to peak, which is why pale-skinned individuals tend to suffer sunburns of the epidermis initially. Dark-skinned individuals can also get sunburns, but are more protected than are pale-skinned individuals.

Too much sun exposure can eventually lead to wrinkling due to the destruction of the cellular structure of the skin, and in severe cases, can cause sufficient DNA damage to result in skin cancer. When there is an irregular accumulation of melanocytes in the skin, freckles appear. Moles are larger masses of melanocytes, and although most are benign, they should be monitored for changes that might indicate the presence of cancer ([link](#)).

Moles



Moles range from benign accumulations of melanocytes to melanomas. These structures populate the landscape of our skin. (credit: the National Cancer Institute)

Note:

Disorders of the...

Integumentary System

The first thing a clinician sees is the skin, and so the examination of the skin should be part of any thorough physical examination. Most skin disorders are relatively benign, but a few, including melanomas, can be fatal if untreated. A couple of the more noticeable disorders, albinism and vitiligo, affect the appearance of the skin and its accessory organs.

Although neither is fatal, it would be hard to claim that they are benign, at least to the individuals so afflicted.

Albinism is a genetic disorder that affects (completely or partially) the coloring of skin, hair, and eyes. The defect is primarily due to the inability of melanocytes to produce melanin. Individuals with albinism tend to appear white or very pale due to the lack of melanin in their skin and hair. Recall that melanin helps protect the skin from the harmful effects of UV radiation. Individuals with albinism tend to need more protection from UV radiation, as they are more prone to sunburns and skin cancer. They also tend to be more sensitive to light and have vision problems due to the lack of pigmentation on the retinal wall. Treatment of this disorder usually involves addressing the symptoms, such as limiting UV light exposure to the skin and eyes. In **vitiligo**, the melanocytes in certain areas lose their ability to produce melanin, possibly due to an autoimmune reaction. This leads to a loss of color in patches ([link](#)). Neither albinism nor vitiligo directly affects the lifespan of an individual.

Vitiligo



Individuals with vitiligo experience depigmentation that results in lighter colored patches of skin. The condition is especially noticeable

on darker skin. (credit:
Klaus D. Peter)

Skin Colors NOT produced by Pigments

Other changes in the appearance of skin coloration can be indicative of diseases associated with other body systems. Liver disease or liver cancer can cause the accumulation of bile and the yellow pigment **bilirubin**, leading to the skin appearing yellow or **jaundiced**. A sudden drop in oxygenation can affect skin color, causing the skin to initially turn ashen (white). With a prolonged reduction in oxygen levels, dark red deoxyhemoglobin becomes dominant in the blood, making the skin appear blue, a condition referred to as **cyanosis** (*kyanos* is the Greek word for “blue”). This happens when the oxygen supply is restricted, as when someone is experiencing difficulty in breathing because of asthma or a heart attack. However, in these cases the effect on skin color has nothing to do with the skin’s pigmentation.

Chapter Review

The skin is composed of two major layers: a superficial epidermis and a deeper dermis. The epidermis consists of several layers beginning with the innermost (deepest) stratum basale (germinatum), followed by the stratum spinosum, stratum granulosum, stratum lucidum (when present), and ending with the outermost layer, the stratum corneum. The topmost layer, the stratum corneum, consists of dead cells that shed periodically and is progressively replaced by cells formed from the basal layer. The stratum basale also contains melanocytes, cells that produce melanin, the pigment primarily responsible for giving skin its color. Melanin is transferred to keratinocytes in the stratum spinosum to protect cells from UV rays.

The dermis connects the epidermis to the hypodermis, and provides strength and elasticity due to the presence of collagen and elastin fibers. It has only two layers: the papillary layer with papillae that extend into the epidermis and the lower, reticular layer composed of loose connective tissue. The hypodermis, deep to the dermis of skin, is the connective tissue that

connects the dermis to underlying structures; it also harbors adipose tissue for fat storage and protection.

Glossary

albinism

genetic disorder that affects the skin, in which there is no melanin production

basal cell

type of stem cell found in the stratum basale and in the hair matrix that continually undergoes cell division, producing the keratinocytes of the epidermis

dermal papilla

(plural = dermal papillae) extension of the papillary layer of the dermis that increases surface contact between the epidermis and dermis

dermis

layer of skin between the epidermis and hypodermis, composed mainly of connective tissue and containing blood vessels, hair follicles, sweat glands, and other structures

desmosome

structure that forms an impermeable junction between cells

elastin fibers

fibers made of the protein elastin that increase the elasticity of the dermis

eleiden

clear protein-bound lipid found in the stratum lucidum that is derived from keratohyalin and helps to prevent water loss

epidermis

outermost tissue layer of the skin

hypodermis

connective tissue connecting the integument to the underlying bone and muscle

integumentary system

skin and its accessory structures

keratin

type of structural protein that gives skin, hair, and nails its hard, water-resistant properties

keratinocyte

cell that produces keratin and is the most predominant type of cell found in the epidermis

keratohyalin

granulated protein found in the stratum granulosum

Langerhans cell

specialized dendritic cell found in the stratum spinosum that functions as a macrophage

melanin

pigment that determines the color of hair and skin

melanocyte

cell found in the stratum basale of the epidermis that produces the pigment melanin

melanosome

intercellular vesicle that transfers melanin from melanocytes into keratinocytes of the epidermis

Merkel cell

receptor cell in the stratum basale of the epidermis that responds to the sense of touch

papillary layer

superficial layer of the dermis, made of loose, areolar connective tissue

reticular layer

deeper layer of the dermis; it has a reticulated appearance due to the presence of abundant collagen and elastin fibers

stratum basale

deepest layer of the epidermis, made of epidermal stem cells

stratum corneum

most superficial layer of the epidermis

stratum granulosum

layer of the epidermis superficial to the stratum spinosum

stratum lucidum

layer of the epidermis between the stratum granulosum and stratum corneum, found only in thick skin covering the palms, soles of the feet, and digits

stratum spinosum

layer of the epidermis superficial to the stratum basale, characterized by the presence of desmosomes

vitiligo

skin condition in which melanocytes in certain areas lose the ability to produce melanin, possibly due an autoimmune reaction that leads to loss of color in patches

Integumentary system Module 3: Accessory Structures of the Skin

By the end of this section, you will be able to:

- Identify the accessory structures of the skin
- Describe the structure and function of hair and nails
- Describe the structure and function of sweat glands and sebaceous glands

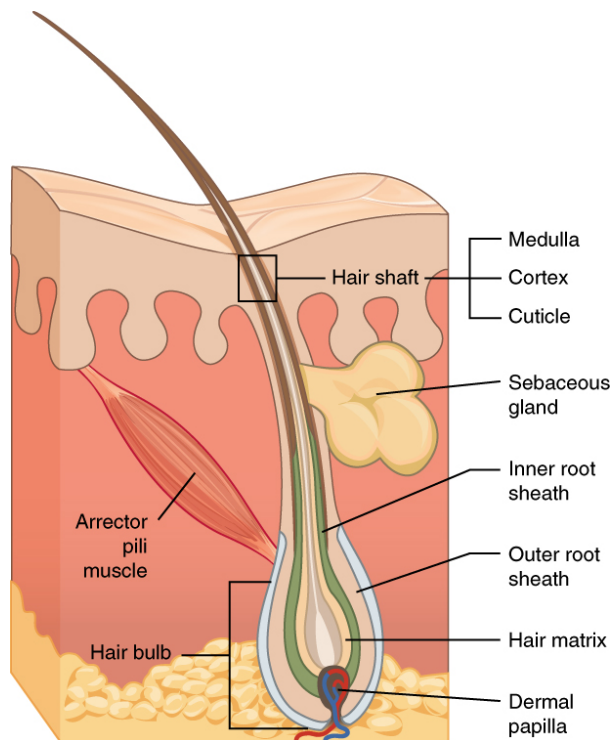
MODULE 3

Accessory structures of the skin include hair, nails, sweat glands, and sebaceous glands. These structures originate from the epidermis and can extend down through the dermis into the hypodermis.

Hair

Hair is a keratinous filament growing out of the epidermis. It is primarily made of dead, keratinized cells. Strands of hair originate in pouch of epidermis that projects into the dermis. This is the **hair follicle**. The **hair shaft** is the part of the hair not anchored to the follicle, and much of this is exposed at the skin's surface. The rest of the hair, which is anchored in the follicle, lies below the surface of the skin and is referred to as the **hair root**. The hair root ends deep in the dermis at the **hair bulb**, and includes a layer of dividing cells called the **hair matrix**. The hair bulb surrounds the **hair papilla**, which is made of connective tissue and contains blood capillaries and nerve endings from the dermis ([\[link\]](#)).

Hair

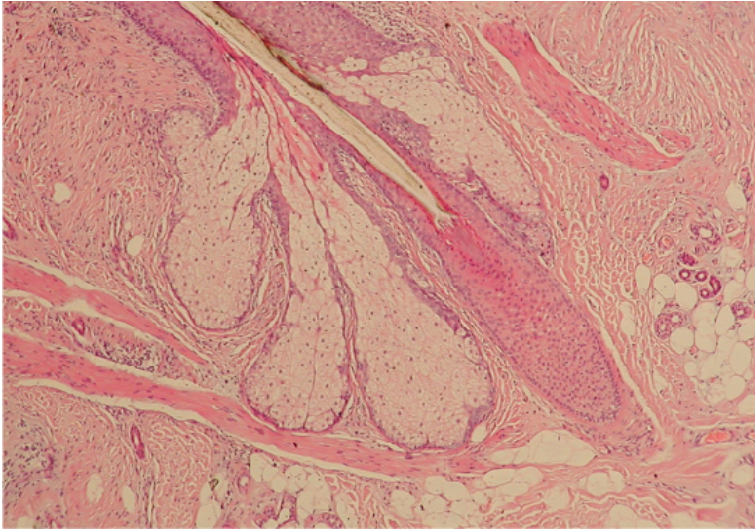


Hair follicles originate in the epidermis and have many different parts.

Just as the basal layer of the epidermis forms the layers of epidermis that get pushed to the surface as the dead skin on the surface sheds, the basal cells of the hair bulb divide and push cells outward in the hair root and shaft as the hair grows. The **medulla** forms the central core of the hair, which is surrounded by the **cortex**, a layer of compressed, keratinized cells that is covered by an outer layer of very hard, keratinized cells known as the **cuticle**. These layers are depicted in a longitudinal cross-section of the hair follicle ([\[link\]](#)). Hair texture (straight, curly) is determined by the shape and structure of the cortex, and to the extent that it is present, the medulla. The shape and structure of these layers are, in turn, determined by the shape of the hair follicle. Keratinization is completed as the cells are pushed to the skin surface to form the shaft of hair that is externally visible. The external hair is completely dead and composed entirely of keratin. For this reason, our hair does not have sensation. Furthermore, you can cut your hair or

shave without damaging the hair structure because the cut is superficial. Most chemical hair removers also act superficially; however, electrolysis and yanking both attempt to destroy the hair bulb so hair cannot grow.

Hair Follicle



The slide shows a cross-section of a hair follicle. Basal cells of the hair matrix in the center differentiate into cells of the inner root sheath. Basal cells at the base of the hair root form the outer root sheath.

LM $\times 4$. (credit: modification of work by “kilbad”/Wikimedia Commons)

Hair serves a variety of **functions**, including protection, sensory input, thermoregulation, and communication. For example, hair on the head protects the skull from the sun. The hair in the nose and ears, and around the eyes (eyelashes) defends the body by trapping and excluding dust particles that may contain allergens and microbes. Hair of the eyebrows prevents sweat and other particles from dripping into and bothering the eyes. Hair also has a sensory function due to sensory innervation by a **hair root plexus**, a cluster of nerves surrounding the base of each hair follicle. Hair is extremely sensitive to air movement or other disturbances in the environment, much more so than the skin surface. This feature is also useful

for the detection of the presence of insects or other potentially damaging substances on the skin surface. Each hair root is connected to a smooth muscle called the **arrector pili** that contracts in response to nerve signals, making the external hair shaft “stand up.” The primary purpose for this is to trap a layer of air to add insulation. This is visible in humans as goose bumps and even more obvious in animals, such as when a frightened cat raises its fur. Of course, this is much more obvious in organisms with a heavier coat than most humans, such as dogs and cats.

Hair Growth

Hair grows and is eventually shed and replaced by new hair. . The first stage of this cycle is called the **growing** phase, during which cells divide rapidly at the root of the hair, pushing the hair shaft up and out. In scalp hair, the length of this phase is measured in years, typically from 2 to 7 years. Finally, during the **resting** phase, the hair follicle is at rest and no new growth occurs. At the end of this phase, which lasts about 2 to 4 months, another growth phase begins. The cells in the hair matrix then produce a new hair, which pushes the old hair out as the growth cycle repeats itself. Hair typically grows at the rate of 0.3 mm per day during the growing phase. On average, 50 hairs are lost and replaced per day. Hair loss occurs if there is more hair shed than what is replaced and can happen due to hormonal or dietary changes. Shorter hairs such as axillary (armpit) hair have shorter growing cycles, thus the hair is pushed out after only a short growth phase, limiting the time the hair can grow before it is replaced. Bald people have such a short hair growth cycle that the hair is shed even before it is visible at the skin's surface. A compulsive habit called trichotillomania compels a person to pull out their hair to relieve stress can cause the appearance of hair loss .Hair loss can also result from the aging process, or the influence of hormones.

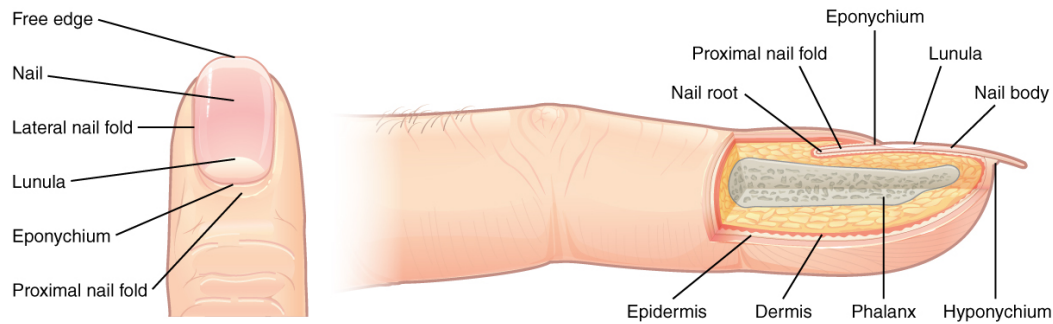
Hair Color and Texture

Similar to the skin, hair gets its color from the pigment melanin, produced by melanocytes in the hair papilla. Different hair color results from differences in the type of melanin, which is genetically determined. As a person ages, the melanin production decreases, and hair tends to lose its color and becomes gray and/or white. "Our hair texture can range anywhere from pin-straight to extremely curly. Follicles that are round in cross-section give rise to straight hair. Those out of which curly hair grows are oval. Very tightly coiled hair is due to the nearly flat, ribbon-like structure of the follicles. This hair texture is very common in people of African ancestry." (<http://genetics.thetech.org/>)

Nails

The nail bed is a specialized structure of the epidermis that is found at the tips of our fingers and toes. The **nail body** (which we refer to as the nail) is formed on the **nail bed**, and protects the tips of our fingers and toes as they are the farthest extremities and the parts of the body that experience the maximum mechanical stress ([\[link\]](#)). In addition, the nail body forms a back-support for picking up small objects with the fingers. The nail body is composed of densely packed dead keratinocytes. The epidermis in this part of the body has evolved a specialized structure upon which nails can form. The nail body forms at the **nail root**, which has a matrix of dividing cells from the stratum basale that enables the nail to grow continuously. The lateral **nail fold** overlaps the nail on the sides, helping to anchor the nail body. The nail fold that meets the proximal end of the nail body forms the **nail cuticle**, also called the **eponychium**. The nail bed is rich in blood vessels, making it appear pink, except at the base, where a thick layer of epithelium over the nail matrix forms a crescent-shaped region called the **lunula** (the "little moon"). The area beneath the free edge of the nail, furthest from the cuticle, is called the **hyponychium**. It consists of a thickened layer of stratum corneum.

Nails



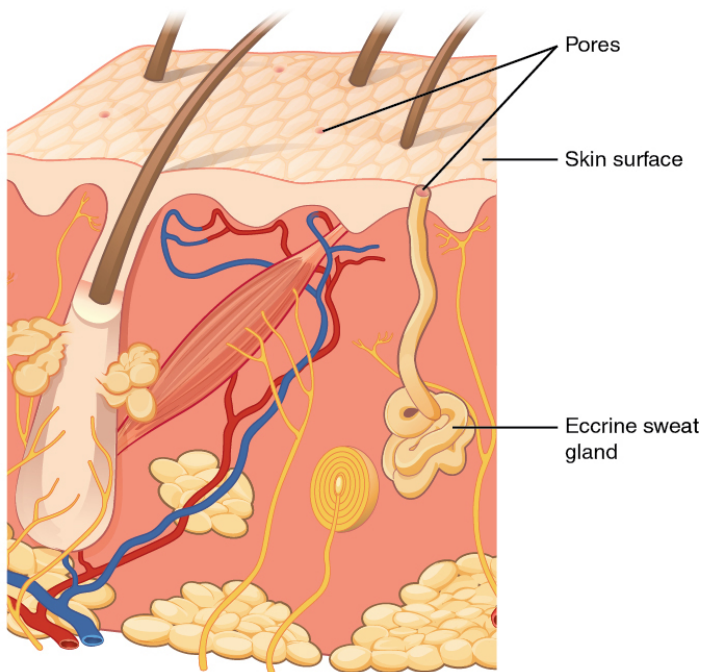
The nail is an accessory structure of the integumentary system.

Sweat Glands

When the body becomes warm, **sweat glands** produce sweat to cool the body. Sweat glands develop from the epidermis and extend into the dermis. The sweat passes from the gland out to the skin via a structure called a **duct**. A duct is a hollow tube that channel secretions from the gland and in this case, to the skin's surface. There are two types of sweat glands, each secreting different products for different purposes.

An **merocrine sweat gland** (sometimes called an eccrine gland) is type of gland that produces a watery sweat for thermoregulation. This sweat is more that 99% water and the remaining percentage is made up of various salts. This is why sweat tastes salty. These glands are found all over the skin's surface, but are especially abundant on the palms of the hand, the soles of the feet, and the forehead ([\[link\]](#)). Eccrine glands are a primary component of thermoregulation in humans and thus help to maintain homeostasis.

Eccrine Gland



Eccrine glands are coiled glands in the dermis that release sweat that is mostly water.

An **apocrine sweat gland** is usually associated with hair follicles in densely hairy areas, such as armpits and genital regions. Apocrine sweat glands are larger than eccrine sweat glands and lie deeper in the dermis, sometimes even reaching the hypodermis, with the duct normally emptying into the hair follicle. In addition to water and salts, apocrine sweat includes organic compounds that make the sweat thicker and subject to bacterial decomposition and subsequent smell. The release of this sweat is under both nervous and hormonal control, and plays a role in the poorly understood human pheromone response. Human pheromones are believed to play a role in sexual attraction. Most commercial antiperspirants use an aluminum-based compound as their primary active ingredient to stop sweat. When the antiperspirant enters the sweat gland duct, the aluminum-based compounds form a physical block in the duct, which prevents sweat from coming out of the pore. A deodorant simply affects the sweat that has come to the surface of the skin. Regular cleansing helps to minimize the number

of bacteria, greatly reducing the unpleasant smell associated with this type of sweat.

Sebaceous Glands

A **sebaceous gland** is a type of oil gland that is found all over the body and helps to lubricate and waterproof the skin and hair. Most sebaceous glands empty into hair follicles. They generate and excrete **sebum**, a mixture of lipids, onto the skin surface, thereby naturally lubricating the dry and dead layer of keratinized cells of the stratum corneum, keeping it pliable. The fatty acids of sebum also have antibacterial properties, and prevent water loss from the skin in low-humidity environments. The secretion of sebum is stimulated by hormones, many of which do not become active until puberty. Thus, sebaceous glands are relatively inactive during childhood.

Chapter Review

Accessory structures of the skin include hair, nails, sweat glands, and sebaceous glands. Hair is made of dead keratinized cells, and gets its color from melanin pigments. Nails, also made of dead keratinized cells, protect the extremities of our fingers and toes from mechanical damage. Sweat glands and sebaceous glands produce sweat and sebum, respectively. Each of these fluids has a role to play in maintaining homeostasis. Sweat cools the body surface when it gets overheated and helps excrete small amounts of metabolic waste. Sebum acts as a natural moisturizer and keeps the dead, flaky, outer keratin layer healthy.

Glossary

anagen

active phase of the hair growth cycle

apocrine sweat gland

type of sweat gland that is associated with hair follicles in the armpits and genital regions

arrector pili

smooth muscle that is activated in response to external stimuli that pull on hair follicles and make the hair “stand up”

catagen

transitional phase marking the end of the anagen phase of the hair growth cycle

cortex

in hair, the second or middle layer of keratinocytes originating from the hair matrix, as seen in a cross-section of the hair bulb

cuticle

in hair, the outermost layer of keratinocytes originating from the hair matrix, as seen in a cross-section of the hair bulb

eccrine sweat gland

type of sweat gland that is common throughout the skin surface; it produces a hypotonic sweat for thermoregulation

eponychium

nail fold that meets the proximal end of the nail body, also called the cuticle

external root sheath

outer layer of the hair follicle that is an extension of the epidermis, which encloses the hair root

glassy membrane

layer of connective tissue that surrounds the base of the hair follicle, connecting it to the dermis

hair

keratinous filament growing out of the epidermis

hair bulb

structure at the base of the hair root that surrounds the dermal papilla

hair follicle

cavity or sac from which hair originates

hair matrix

layer of basal cells from which a strand of hair grows

hair papilla

mass of connective tissue, blood capillaries, and nerve endings at the base of the hair follicle

hair root

part of hair that is below the epidermis anchored to the follicle

hair shaft

part of hair that is above the epidermis but is not anchored to the follicle

hyponychium

thickened layer of stratum corneum that lies below the free edge of the nail

internal root sheath

innermost layer of keratinocytes in the hair follicle that surround the hair root up to the hair shaft

lunula

basal part of the nail body that consists of a crescent-shaped layer of thick epithelium

medulla

in hair, the innermost layer of keratinocytes originating from the hair matrix

nail bed

layer of epidermis upon which the nail body forms

nail body

main keratinous plate that forms the nail

nail cuticle

fold of epithelium that extends over the nail bed, also called the eponychium

nail fold

fold of epithelium that extend over the sides of the nail body, holding it in place

nail root

part of the nail that is lodged deep in the epidermis from which the nail grows

sebaceous gland

type of oil gland found in the dermis all over the body and helps to lubricate and waterproof the skin and hair by secreting sebum

sebum

oily substance that is composed of a mixture of lipids that lubricates the skin and hair

sudoriferous gland

sweat gland

telogen

resting phase of the hair growth cycle initiated with catagen and terminated by the beginning of a new anagen phase of hair growth

Integumentary System Module 4: Functions of the Integumentary System

By the end of this section, you will be able to:

- Describe the different functions of the skin and the structures that enable them
- Explain how the skin helps maintain body temperature

Protection

The skin protects the rest of the body from the basic elements of nature such as wind, water, and UV sunlight. It acts as a protective barrier against water loss, due to the presence of layers of keratin and oils in the stratum corneum. It also is the first line of defense against abrasive activity due to contact with grit, microbes, or harmful chemicals. Sweat excreted from sweat glands deters microbes from over-colonizing the skin surface.

Note:

Everyday Connection

Tattoos and Piercings

The word “armor” evokes several images. You might think of a Roman centurion or a medieval knight in a suit of armor. The skin, in its own way, functions as a form of armor—body armor. It provides a barrier between your vital, life-sustaining organs and the influence of outside elements that could potentially damage them.

For any form of armor, a breach in the protective barrier poses a danger. The skin can be breached when a child skins a knee or an adult has blood drawn—one is accidental and the other medically necessary. However, you also breach this barrier when you choose to “accessorize” your skin with a tattoo or body piercing. Because the needles involved in producing body art and piercings must penetrate the skin, there are dangers associated with the practice. **These include allergic reactions; skin infections; blood-borne diseases, such as tetanus, hepatitis C, and hepatitis D; and the growth of scar tissue.** Despite the risk, the practice of piercing the skin for decorative purposes has become increasingly popular. According to the

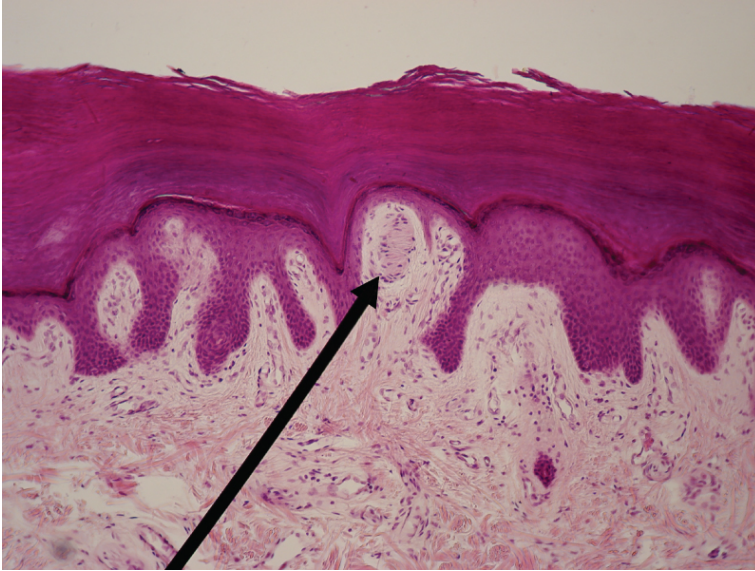
American Academy of Dermatology, 24 percent of people from ages 18 to 50 have a tattoo.

Sensory Function

The fact that you can feel an ant crawling on your skin, allowing you to flick it off before it bites, is because the skin, and especially the hairs projecting from hair follicles in the skin, can sense changes in the environment. The **hair root plexus** surrounding the base of the hair follicle senses a disturbance, and then transmits the information to the central nervous system (brain and spinal cord), which can then respond by activating the skeletal muscles of your eyes to see the ant and the skeletal muscles of the body to act against the ant.

The skin acts as a sense organ because the epidermis, dermis, and the hypodermis contain specialized sensory nerve structures that detect touch, surface temperature, and pain. These receptors are more concentrated on the tips of the fingers, which are most sensitive to touch, especially the **Meissner corpuscle** (tactile corpuscle) ([\[link\]](#)), which responds to light touch, and the **Pacinian corpuscle** (lamellated corpuscle), which responds to vibration. Merkel cells, seen scattered in the stratum basale, are also touch receptors. In addition to these specialized receptors, there are sensory nerves connected to each hair follicle, pain and temperature receptors scattered throughout the skin, and motor nerves innervate the arrector pili muscles and glands. This rich innervation helps us sense our environment and react accordingly.

Light Micrograph of a Meissner Corpuscle



In this micrograph of a skin cross-section, you can see a Meissner corpuscle (arrow), a type of touch receptor located in a dermal papilla adjacent to the basement membrane and stratum basale of the overlying epidermis. LM $\times$ 100. (credit: “Wbensmith”/Wikimedia Commons)

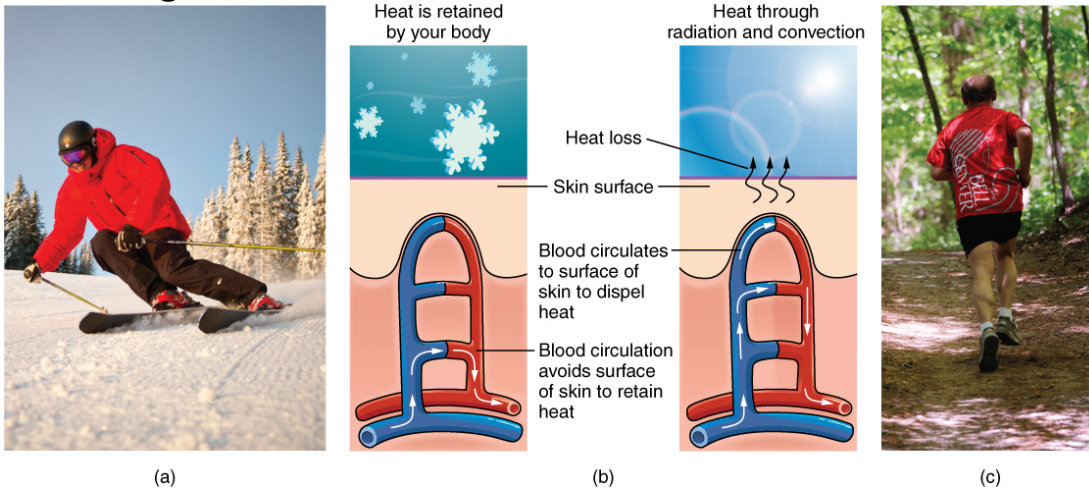
Thermoregulation

The integumentary system helps regulate body temperature through its tight association with the **sympathetic nervous system**, the division of the nervous system involved in our fight-or-flight responses. The sympathetic nervous system is continuously monitoring body temperature and initiating appropriate motor responses. Recall that sweat glands, accessory structures to the skin, secrete water, salt, and other substances to cool the body when it becomes warm. Even when the body does not appear to be noticeably sweating, approximately 500 mL of sweat (insensible perspiration) are secreted a day. If the body becomes excessively warm due to high temperatures, vigorous activity ([link](#)ac), or a combination of the two, sweat glands will be stimulated by the sympathetic nervous system to

produce large amounts of sweat, as much as 0.7 to 1.5 L per hour for an active person. When the sweat evaporates from the skin surface, the body is cooled as body heat is dissipated.

In addition to sweating, **arterioles in the dermis** dilate (become larger) so that excess heat carried by the blood can escape through the skin and into the surrounding environment ([link](#)b). This accounts for the skin redness that many people experience when exercising.

Thermoregulation



During strenuous physical activities, such as skiing (a) or running (c), the dermal blood vessels dilate and sweat secretion increases (b). These mechanisms prevent the body from overheating. In contrast, the dermal blood vessels constrict to minimize heat loss in response to low temperatures (b). (credit a: “Trysil”/flickr; credit c: Ralph Daily)

When body temperatures drop, the arterioles constrict (become narrower) to minimize heat loss, particularly in the ends of the digits and tip of the nose. This reduced circulation can result in the skin taking on a whitish hue. Although the temperature of the skin drops as a result, passive heat loss is prevented, and internal organs and structures remain warm. If the temperature of the skin drops too much (such as environmental temperatures below freezing), the conservation of body core heat can result in the skin actually freezing, a condition called **frostbite**.

Note:

Aging and the...

Integumentary System

All systems in the body accumulate subtle and some not-so-subtle changes as a person ages. Among these changes are **reductions in cell division, metabolic activity, blood circulation, hormonal levels, and muscle strength** ([\[link\]](#)). In the skin, these changes are reflected in decreased mitosis in the stratum basale, leading to a thinner epidermis. The dermis, which is responsible for the elasticity and resilience of the skin, exhibits a reduced ability to regenerate, which leads to slower wound healing. The hypodermis, with its fat stores, loses structure due to the reduction and redistribution of fat, which in turn contributes to the thinning and sagging of skin.

Aging

Generally, skin, especially on the face and hands, starts to display the first noticeable signs of aging, as it loses its elasticity over time. (credit: Janet Ramsden)

The accessory structures also have lowered activity, generating thinner hair and nails, and reduced amounts of sebum and sweat. A **reduced sweating ability** can cause some elderly to be intolerant to extreme heat. Other cells in the skin, such as melanocytes and dendritic cells, also become less

active, leading to a paler skin tone and lowered immunity. Wrinkling of the skin occurs due to breakdown of its structure, which results from decreased collagen and elastin production in the dermis, weakening of muscles lying under the skin, and the inability of the skin to retain adequate moisture. Many anti-aging products can be found in stores today. In general, these products try to rehydrate the skin and thereby fill out the wrinkles, and some stimulate skin growth using hormones and growth factors. Additionally, invasive techniques include collagen injections to plump the tissue and injections of BOTOX[®] (the name brand of the botulinum neurotoxin) that paralyze the muscles that crease the skin and cause wrinkling.

Vitamin D Synthesis

The epidermal layer of human skin synthesizes **vitamin D** when exposed to UV radiation. In the presence of sunlight, a form of vitamin D is synthesized from cholesterol in the skin. Vitamin D is essential for normal absorption of calcium and phosphorous, which are required for healthy bones. The absence of sun exposure can lead to a lack of vitamin D in the body, leading to a condition called **rickets**, a painful condition in children where the bones are misshapen due to a lack of calcium, causing bowleggedness. Elderly individuals who suffer from vitamin D deficiency can develop a condition called osteomalacia, a softening of the bones. In present day society, vitamin D is added as a supplement to many foods, including milk and orange juice, compensating for the need for sun exposure.

In addition to its essential role in bone health, vitamin D is essential for general immunity against bacterial, viral, and fungal infections. Recent studies are also finding a link between insufficient vitamin D and cancer.

Chapter Review

The skin plays important roles in protection, sensing stimuli, thermoregulation, and vitamin D synthesis. It is the first layer of defense to

prevent dehydration, infection, and injury to the rest of the body. Sweat glands in the skin allow the skin surface to cool when the body gets overheated. Thermoregulation is also accomplished by the dilation or constriction of heat-carrying blood vessels in the skin. Immune cells present among the skin layers patrol the areas to keep them free of foreign materials. Fat stores in the hypodermis aid in both thermoregulation and protection. Finally, the skin plays a role in the synthesis of vitamin D, which is necessary for our well-being but not easily available in natural foods.

References

American Academy of Dermatology (US). Tattoos and body piercings [Internet]. Schaumburg, IL; c2013 [cited 2012 Nov 1]. Available from: <http://www.aad.org/media-resources/stats-and-facts/prevention-and-care/tattoos-and-body-piercings/>.

Glossary

Meissner corpuscle

(also, tactile corpuscle) receptor in the skin that responds to light touch

Pacinian corpuscle

(also, lamellated corpuscle) receptor in the skin that responds to vibration

rickets

disease in children caused by vitamin D deficiency, which leads to the weakening of bones

vitamin D

compound that aids absorption of calcium and phosphates in the intestine to improve bone health

Integumentary System Module 5: Diseases, Disorders, and Injuries of the Integumentary System

By the end of this section, you will be able to:

- Describe several different diseases and disorders of the skin
- Describe the effect of injury to the skin and the process of healing

The integumentary system is susceptible to a variety of diseases, disorders, and injuries. These range from annoying but **benign** (usually relatively harmless) bacterial or fungal infections that are categorized as disorders, to skin cancer and severe burns, which can be fatal. In this section, you will learn several of the most common skin conditions.

Diseases

One of the most talked about diseases is skin cancer. Cancer is a broad term that describes diseases caused by abnormal cells in the body dividing uncontrollably. Most cancers are identified by the organ or tissue in which the cancer originates. One common form of cancer is skin cancer. The Skin Cancer Foundation reports that **one in five Americans** will experience some type of skin cancer in their lifetime. The breakdown of the ozone layer in the atmosphere and the resulting increase in exposure to UV radiation has contributed to its rise. Overexposure to UV radiation damages DNA, which can lead to cancer. Although melanin offers some protection against DNA damage from the sun, often it is not enough. The fact that cancers can also occur on areas of the body that are normally not exposed to UV radiation suggests that there are additional factors that can lead to cancer of the skin.

In general, cancers result from an accumulation of DNA mutations. These mutations can result in cell populations that do not die when they should and uncontrolled cell growth that leads to tumors. Although many tumors are benign, some produce cells that can mobilize and establish tumors in other organs of the body; this process is referred to as **metastasis**. Cancers are characterized by their ability to metastasize.

Basal Cell Carcinoma

Basal cell carcinoma is a form of cancer that affects the actively dividing stem cells in the stratum basale of the epidermis. It is the most common of all cancers that occur in the United States and is frequently found on the head, neck, arms, and back, which are areas that are most susceptible to long-term sun exposure. Although UV rays are the main culprit, exposure to other agents, such as radiation and arsenic, can also lead to this type of cancer. Wounds on the skin due to open sores, tattoos, burns, etc. may be also increase the chance of future cancers as well. Basal cell carcinomas start in the stratum basale and usually spread along this boundary. At some point, they begin to grow toward the surface and become an uneven patch, bump, growth, or scar on the skin surface ([\[link\]](#)). Like most cancers, basal cell carcinomas respond best to treatment when caught early. Treatment options include surgery, freezing or **cryosurgery**, and topical ointments (Mayo Clinic 2012).

Basal Cell Carcinoma



Basal cell carcinoma
can take several
different forms. Similar
to other forms of skin
cancer, it is readily
cured if caught early
and treated. (credit:
John Hendrix, MD)

Squamous Cell Carcinoma

Squamous cell carcinoma is a cancer that affects the **keratinocytes of the stratum spinosum** and presents as lesions commonly found on the scalp, ears, and hands ([\[link\]](#)). It is the second most common skin cancer. The American Cancer Society reports that two of 10 skin cancers are squamous cell carcinomas, and it is more aggressive than basal cell carcinoma. If not removed, these carcinomas can metastasize. Surgery and radiation are used to cure squamous cell carcinoma.

Squamous Cell Carcinoma

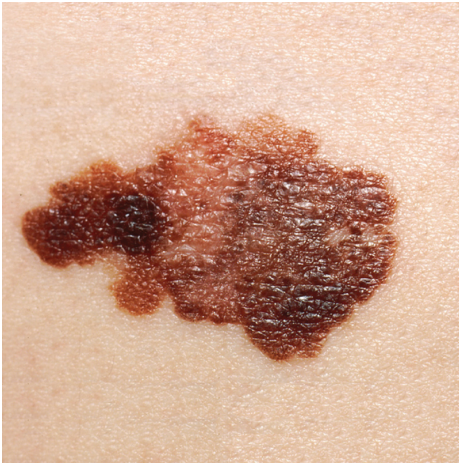


Squamous cell carcinoma presents here as a lesion on an individual's nose. (credit: the National Cancer Institute)

Melanoma

A **malignant melanoma** is a cancer characterized by the uncontrolled growth of melanocytes, the pigment-producing cells in the epidermis. Typically, a melanoma develops from a mole. It is the most fatal of all skin cancers, as it is highly metastatic and can be difficult to detect before it has spread to other organs. Melanomas usually appear as asymmetrical brown and black patches with uneven borders and a raised surface ([\[link\]](#)). Treatment typically involves surgical excision and immunotherapy.

Melanoma



Melanomas typically present as large brown or black patches with uneven borders and a raised surface. (credit: the National Cancer Institute)

Doctors often give their patients the following ABCDE mnemonic to help with the diagnosis of early-stage melanoma. If you observe a mole on your body displaying these signs, consult a doctor.

- **A**symmetry – the two sides are not symmetrical
- **B**orders – the edges are irregular in shape
- **C**olor – the color is varied shades of brown or black
- **D**iameter – it is larger than 6 mm (0.24 in)
- **E**volving – its shape has changed

Skin Disorders

Two common skin disorders are eczema and acne. Eczema is an inflammatory condition and occurs in individuals of all ages. Acne involves the clogging of pores, which can lead to infection and inflammation, and is

often seen in adolescents. Other disorders, not discussed here, include seborrheic dermatitis (on the scalp), psoriasis, cold sores, impetigo, scabies, hives, and warts.

Eczema

Eczema is an allergic reaction that manifests as dry, itchy patches of skin that resemble rashes ([\[link\]](#)). It may be accompanied by swelling of the skin, flaking, and in severe cases, bleeding. Many who suffer from eczema have antibodies against dust mites in their blood, but the link between eczema and allergy to dust mites has not been proven. Symptoms are usually managed with moisturizers, corticosteroid creams, and immunosuppressants.

Eczema

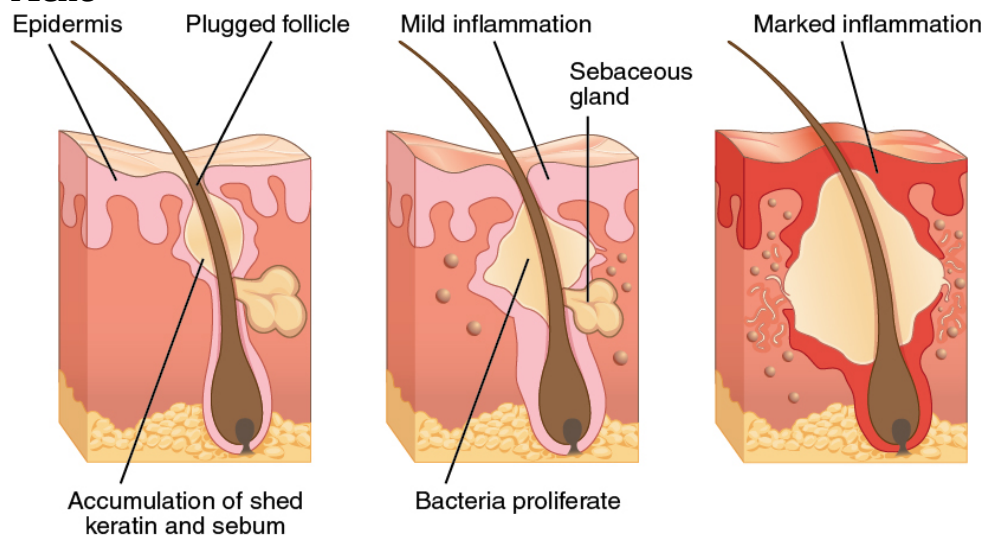


Eczema is a common skin disorder that presents as a red, flaky rash. (credit: “Jambula”/Wikimedia Commons)

Acne

Acne is a skin disturbance that typically occurs on areas of the skin that are rich in sebaceous glands (face and back). It is most common along with the onset of puberty due to associated hormonal changes, but can also occur in infants and continue into adulthood. Hormones, such as androgens, stimulate the release of sebum. An overproduction and accumulation of sebum along with keratin can block hair follicles. This plug is initially white. The sebum, when oxidized by exposure to air, turns black. Acne results from infection by acne-causing bacteria (*Propionibacterium* and *Staphylococcus*), which can lead to redness and potential scarring due to the natural wound healing process ([link](#)).

Acne



Acne is a result of over-productive sebaceous glands, which leads to formation of blackheads and inflammation of the skin.

Injuries

Because the skin is the part of our bodies that meets the world most directly, it is especially vulnerable to injury. Injuries include burns and wounds, as well as scars and calluses. The formation of calluses is caused by an accumulation of dead skin cells that harden and thicken over an area of the foot. This callus formation is the body's defense mechanism to protect the

foot against excessive pressure and friction. Calluses are normally found on the ball-of-the-foot, the heel, and/or the inside of the big toe.

(<http://foot.com/site/foot-conditions/calluses>) Other injuries can be caused by sharp objects, heat, or excessive pressure or friction to the skin.

Blisters are small pockets of liquid that form on the outer layer of the skin after the skin becomes damaged (usually caused by forceful rubbing or burning). Blisters prevent the area from becoming further damaged by protecting the skin underneath and giving it adequate time to heal.

(<http://www.medicalnewstoday.com/articles/264783.php>) When the skin is wounded and there is a break in the body's tissues, the body produces more of a protein called collagen as part of the healing process. Collagen builds up where the tissue has been damaged, helping to heal and strengthen the wound. (<http://www.nhs.uk/conditions/Scars/Pages/Introduction.aspx>) Also contributing to the appearance of scars is the absence of sweat glands, sebaceous glands and hair follicles.

Skin injuries set off a healing process that occurs in several overlapping stages. The first step to repairing damaged skin is the formation of a blood clot that helps stop the flow of blood and scabs over with time. Many different types of cells are involved in wound repair, especially if the surface area that needs repair is extensive. Before the basal stem cells of the stratum basale can recreate the epidermis, fibroblasts mobilize and divide rapidly to repair the damaged tissue by collagen deposition, forming granulation tissue. Blood capillaries follow the fibroblasts and help increase blood circulation and oxygen supply to the area. Immune cells, such as macrophages, roam the area and engulf any foreign matter to reduce the chance of infection.

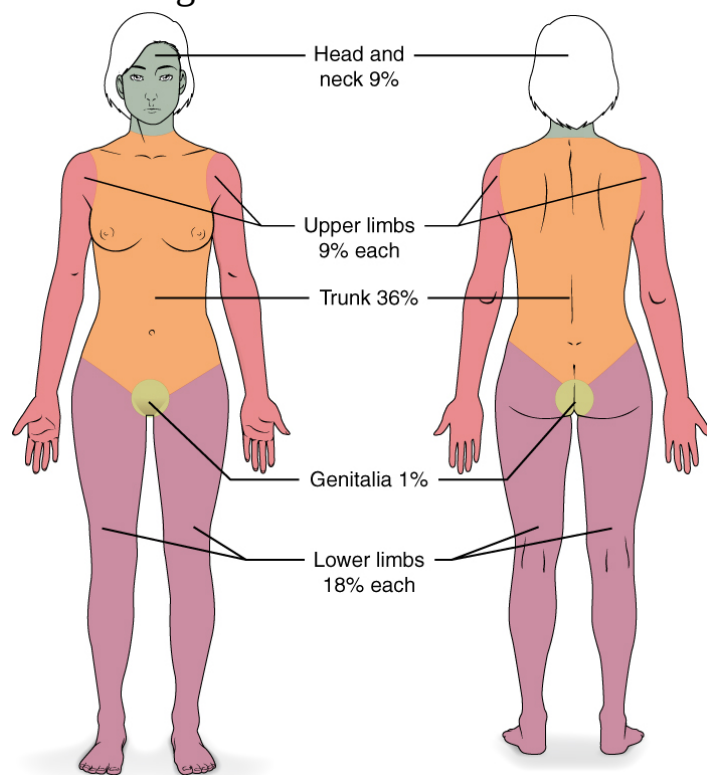
Burns

A burn results when the skin is damaged by intense heat, radiation, electricity, or chemicals. The damage results in the death of skin cells, which can lead to a massive loss of fluid. This loss of fluid is the primary medical concern immediately following a burn injury. Dehydration, electrolyte imbalance, and renal and circulatory failure follow dehydration,

all of which can be fatal. Burn patients are treated with intravenous fluids to offset dehydration, as well as intravenous nutrients that enable the body to repair tissues and replace lost proteins. A patient recovering from extensive burns will have a higher metabolic rate and need to ingest more nutrients to meet the demands of a healing body. Another serious threat to the lives of burn patients is infection. Burned skin is extremely susceptible to bacteria and other pathogens, due to the loss of protection by intact layers of skin.

Burns are sometimes measured in terms of the size of the total surface area affected. This is referred to as the “**rule of nines**”, which associates specific anatomical areas with a percentage that is a factor of nine ([\[link\]](#)). This allows first responders to quickly estimate the percentage of the **BSA** (body surface area) that is damaged. This calculation allows a quick decision to be made about the level of care a patient needs. A patient with extensive burns needs to be sent to a burn center quickly for life saving treatment unavailable at regular hospitals.. Burns are also classified by the degree of their severity.

Calculating the Size of a Burn



The size of a burn will guide decisions

made about the need for specialized treatment. Specific parts of the body are associated with a percentage of body area.

Classification of Burns

A **first-degree burn** is a superficial burn that affects only the epidermis. Although the skin may be painful and swollen, these burns typically heal on their own within a few days. The skin will usually appear red. A sunburn fits into the category of a first-degree burn. A **second-degree burn** goes deeper and affects both the epidermis and the upper portion of the dermis. These burns result in swelling and a painful blistering of the skin. It is important to keep the burn site clean and sterile to prevent infection. If this is done, the burn will heal within several weeks. A **third-degree burn** fully extends into the epidermis and dermis, destroying the tissue and affecting the nerve endings and sensory function. These are serious burns that may appear white, red, or black; they require medical attention and will heal slowly without it. Oddly, third-degree burns are usually not as painful because the nerve endings themselves are damaged. Third-degree or full-thickness burns cannot be repaired by the body, because the local tissues used for repair are damaged and require **debridement** (removal of damaged skin tissues), or even amputation in severe cases. Usually this procedure is followed by grafting of the skin from an unaffected part of the body, or from skin grown in tissue culture for grafting purposes. Damaged skin may also be replaced by synthetic skin, animal skin or the skin of a cadaver.

Scars and Keloids

Most cuts or wounds, with the exception of ones that only scratch the surface (the epidermis), lead to scar formation. A **scar** is collagen-rich skin formed after the process of wound healing that differs from normal skin. Scarring occurs in cases in which there is repair of skin damage, but the skin fails to regenerate the original skin structure. Fibroblasts generate scar tissue in the form of collagen, and the bulk of repair is due to the basket-

weave pattern generated by collagen fibers and does not result in regeneration of the typical cellular structure of skin. Instead, the tissue is fibrous in nature and does not allow for the regeneration of accessory structures, such as hair follicles, sweat glands, or sebaceous glands.

Sometimes, there is an overproduction of scar tissue, because the process of collagen formation does not stop when the wound is healed; this results in the formation of a raised or hypertrophic scar called a **keloid**. In contrast, scars that result from acne and chickenpox have a sunken appearance and are called atrophic scars.

Scarring of skin after wound healing is a natural process and does not need to be treated further. Application of mineral oil and lotions may reduce the formation of scar tissue. However, modern cosmetic procedures, such as dermabrasion, laser treatments, and filler injections have been invented as remedies for severe scarring. All of these procedures try to reorganize the structure of the epidermis and underlying collagen tissue to make it look more natural.

Bedsores and Stretch Marks

Skin and its underlying tissue can be affected by excessive pressure. One example of this is a **decubitis ulcer** also known as a bedsore. Decubitis ulcers, are caused by constant, long-term, unrelieved pressure on certain body parts that are bony, reducing blood flow to the area and leading to **necrosis** (tissue death). Bedsores are most common in elderly patients who have debilitating conditions that cause them to be immobile or to individuals confined to a wheelchair. Most hospitals and long-term care facilities have the practice of turning the patients every few hours to prevent the incidence of bedsores. If left untreated by removal of necrotized tissue, bedsores can be fatal if they become infected.

The skin can also be affected by pressure associated with rapid growth. **Striae (singular stria)** or stretch mark results when the dermis is stretched beyond its limits of elasticity, as the skin stretches to accommodate the excess pressure. Stretch marks usually accompany rapid weight gain during

puberty and pregnancy. They initially have a reddish hue, but lighten over time. Other than for cosmetic reasons, treatment of stretch marks is not required. They occur most commonly over the hips, breasts and abdomen.

Chapter Review

Skin cancer is a result of damage to the DNA of skin cells, often due to excessive exposure to UV radiation. Basal cell carcinoma and squamous cell carcinoma are highly curable, and arise from cells in the stratum basale and stratum spinosum, respectively. Melanoma is the most dangerous form of skin cancer, affecting melanocytes, which can spread/metastasize to other organs. Burns are an injury to the skin that occur as a result of exposure to extreme heat, radiation, or chemicals. First-degree and second-degree burns usually heal quickly, but third-degree burns can be fatal because they penetrate the full thickness of the skin. Scars occur when there is repair of skin damage. Fibroblasts generate scar tissue in the form of collagen, which forms a basket-weave pattern that looks different from normal skin.

Bedsore and stretch marks are the result of excessive pressure on the skin and underlying tissue. Bedsore is characterized by necrosis of tissue due to immobility, whereas stretch marks result from rapid growth. Eczema is an allergic reaction that manifests as a rash, and acne results from clogged sebaceous glands. Eczema and acne are usually long-term skin conditions that may be treated successfully in mild cases. Calluses and corns are the result of abrasive pressure on the skin.

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Glossary

acne

skin condition due to infected sebaceous glands

basal cell carcinoma

cancer that originates from basal cells in the epidermis of the skin

bedsore

sore on the skin that develops when regions of the body start necrotizing due to constant pressure and lack of blood supply; also called decubitis ulcers

callus

thickened area of skin that arises due to constant abrasion

corn

type of callus that is named for its shape and the elliptical motion of the abrasive force

eczema

skin condition due to an allergic reaction, which resembles a rash

first-degree burn

superficial burn that injures only the epidermis

fourth-degree burn

burn in which full thickness of the skin and underlying muscle and bone is damaged

keloid

type of scar that has layers raised above the skin surface

melanoma

type of skin cancer that originates from the melanocytes of the skin

metastasis

spread of cancer cells from a source to other parts of the body

scar

collagen-rich skin formed after the process of wound healing that is different from normal skin

second-degree burn

partial-thickness burn that injures the epidermis and a portion of the dermis

squamous cell carcinoma

type of skin cancer that originates from the stratum spinosum of the epidermis

stretch mark

mark formed on the skin due to a sudden growth spurt and expansion of the dermis beyond its elastic limits

third-degree burn

burn that penetrates and destroys the full thickness of the skin (epidermis and dermis)